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Technical Report ARESI-TR-08001

DESIGN AND DEVELOPMENT OF PA190 AND PA191 METAL SHIPPING CONTAINER FOR 60-mm MORTAR AMMUNITION

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14. ABSTRACT

This report details the development program of PA190 and PA191 metal container for the 60-mm mortar ammunition. The 60-mm mortar ammunition is presently packed in three layers: fiber tube, metal container, and wood wire bound box. The new metal containers possess a unique design that provides the same level of protection as the current pack without the need for the wire bound box. As a result, the new pack significantly reduces material and pack out costs at the loading facility. It will also provide quicker access to the ammunition, reduce weight and logistics footprint. The new PA190 and PA191 meet all performance requirements of United Nations, U.S. Department of Transportation, and Department of Defense.

15. SUBJECT TERMS

PA190 PA919 PA124 PA154 60-mm mortar ammunition Wire bound box

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BACKGROUND

Traditionally, military ammunition is packaged using two metal gasket and sealed containers loaded within a wood wire-bound box. Over time, wood continues to become more expensive and preservative treatments leach out to contaminate the environment. The treated wood also outgases hazardous vapors and is a bare skin contact hazard to the user. Thus, the wire-bound box adds cost to the pack and hazards to the environment and user. The elimination of the wire-bound box for small rectangular ammunition containers was attempted many times in the past, but failed each time.

The Packaging Division of the U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, New Jersey has an ongoing Project Manager for Maneuver Ammunition Systems (PM-MAS) funded effort to eliminate the wire-bound box for the M2A1 metal container for small caliber ammunition items. The Small Caliber Ammunition Packaging team was having some success, but progressing slowly. In addition to passing rough handling transportation testing, the small caliber ammunition container also has numerous interface requirements with the various weapon systems that use the container ammunition.

Seeing an opportunity to innovate military packaging, the Packaging Mortar team proposed a challenging program to the Project Manager Combat Ammunition Systems (PM-CAS) to eliminate the use of the wire-bound box for the much heavier 60-mm mortars. The program was accepted contingent on the final design passing the Packaging Qualification Test in accordance with (IAW) tailored MIL-STD-1904. Funding for this effort was obtained via a grant from the Reduction in Total Ownership Cost (R-TOC) program sponsored by the Under Secretary of Defense.

To minimize duplication of effort, the Packaging Division forged a collaborative effort between the two development teams to eliminate the wire-bound box over-pack for the M2A1 (for small caliber items), the PA0 (for mortar 60-mm smoke rounds), and the PA124 (for 60-mm infrared/high explosive rounds) metal containers.

PROGRAM OBJECTIVES/GOALS

A major Army goal is to ensure ammunition is delivered to our troops using the lightest, space efficient and cost effective methods available. To achieve this goal, the Packaging Division focused on improvements that could be applied to existing metal containers so that they can be shipped without the wire-bound box in tactical rough handling, transportation environments.

The current metal container design lacks a critical cover positive stop feature that prevents to gasket from being damaged when the containers are stacked. The container sidewalls need to be strengthened to prevent buckling and the material needs to be strengthened at the bottom to limit excessive tin caning or crumpling at the corners or edges during drop testing. The container must maintain a 3 psig seal when tested IAW MIL-STD-1904 and the unitization design needs to pass testing IAW MIL-STD-1660.

The designs developed need to take advantage of commonality of tooling and leverage successful designs already in the field as much as possible. If the wire-bound can be eliminated, the material savings for the M2A1 is estimated as $15, for the PA70 is estimated at $18, and for the PA124 is estimated as $20. Other associated savings are reduced load, assemble, and pack assembly time, material ordering, storage space, shipping weight, and unit transportation cost.

APPROACH

Generate concepts, build prototypes, conduct development risk reduction testing, and qualify re-design containers that achieve the program goals. The metal container cover for the M2A1 was planned to be re-designed by the Small Caliber Ammunition Packaging Team. The Mortar Packaging Team planned to develop a reinforced container body based on the PA70 and PA124 metal containers.

Production representative containers were subject to developmental testing. Contracts were awarded to B-Way Corporation to provide sets of 12 production quality containers for development. Each set of 12 containers was subject to risk reduction testing as follows: pressure retention test, loose cargo vibration test, pressure retention test, 3-ft drop test, pressure retention test, and 7-ft drop test. Temperature conditioning was 12 hrs in cold condition temperature at -65°F or in hot condition temperature at +160°F. The samples were tested as quickly as possible after removal from hot and cold conditioning chamber to maintain the specified temperature level as close as possible to the required value.

In all, four development sets of 12 containers were purchased. Each successive set of 12 containers had modifications to address marginal performance or failures until all the containers passed. Once the modified prototypes passed the development test, then the design was frozen and a fifth set of 12 production quality containers o the final design were ordered to conduct the Packaging Qualification Test IAW tailored MIL-STD-1904.

ACTIVITIES

Development Testing (app. A)

First set of 12 containers were PA124 containers that were delivered with strengthening ribs welded to the container side walls, but without the critical positive stop. Three of these containers failed the pressure retention test after 3-ft drop testing. One container in the cold condition leaked from the cover and another from a bottom corner. For hot condition, one container leaked from the cover. Thus, the modified PA124 container needed strengthening at the cover and bottom.

The second set of 12 containers were delivered with the strengthen M2A1 cover, positive stop, and strengthening ribs. Three containers from hot condition failed pressure retention test at the cover after 3-ft drop test. The M2A1 cover was thus determined to not be strong enough for the mortar pack and the team needed to take a new approach.

As a result, for the third set of 12 containers, PA124 container bodies were ordered with strengthening ribs and PA154 double latch covers. None of these containers leaked from the cover, but there were minor leaks from the container bottom after the 3-ft drop. One minor leak cam from the cold condition and two minor leaks were from hot condition. The data obtained from the third set of tests showed that the bottom design was marginal and needed to be strengthened.

The fourth set of 12 containers was made having a thicker bottom, thicker sidewalls, and had a 0.25 in. thick piece of plywood added at the bottom of each container. None of these containers leaked from pressure retention testing after the 3-ft drop test and design was frozen.

Qualification Testing (app. B)

The re-designed container includes the following features that are different from the current technical data package: use of a PA154 cover, use of PA154 positive stop at each handle, thicker sidewall and bottom, added strengthening ribs welded to container sides, and a plywood plank placed at the bottom of the container.

A fifth set of the 12 production quality containers of the final frozen design were then purchased from B-Way and sent to ARDEC's bldg 3109 for tailored MIL-STD-1904 testing. They were loaded with 8 60-mm mortars in fiber tubes and h ad the plywood cushion placed at the container bottom. Building 3109 test group conducted the testing independently from this office and all containers passed the sequence of tests.

Instrumented Testing (app. C)

Additional PA124 and PA191 containers were obtained for instrumented drop tests. The objective of these tests was to determine the peak g-force and maximum impact load of various 60-mm mortar packaging systems during vertical drops from 7 ft height. The packaging systems testes are listed in the following table.

Weights of four tested 60-mm packaging system configurations

System	Cushion material	System weight (lb)
Current wire-bound container	Paper	114.4
Current wire-bound container	Plywood	114.7
Reinforced steel container	Foam	51.7
Reinforced steel container	Plywood	51.9

All systems were vertically dropped (fin upward) from 7 ft height as per MIL-STD-1904A. Two consecutive drops were conducted for each packaging configuration. The plywood cushion produced up to 50% less g-force transmission to the packed items then all the other cushion materials used.

CONCLUSIONS

The design selected showed promise as it passed the Packaging Qualification test in accordance with (IAW) a tailored MIL-STD-1904 sequence. The PA190 is approved by analogy. The containers developed are very producible with a minimum of new tooling and start up cost at the current manufacturer facility. Based on the instrumented drop tests, it is clear using the plywood cushion and PA154 double latch cover significantly reduces the g-force transmission from 7 ft vertical drops and thus provides better protection to the packed rounds then the current design. The unitization configuration to be used with these new containers leverages the molded plastic sheet (interlock) design developed for the M2A1 wire-bound elimination effort, which passed MIL-STD-1660 testing. Thus, after this testing, the containers demonstrated satisfactory strength and integrity to provide the proper protection to the ammunition IAW Department of Transportation and Department of Defense packaging standards.

RECOMMENDATIONS

Recommend to transition the PAA190 and PA191 improved mortar ammunition packaging container to Project Manager Combat Ammunition Systems for future development and fielding after successfully passing the required safety conformation testing.

APPENDIX A
DEVELOPMENTAL TESTING OF 60-mm FOR PA190 AND PA191 METAL CONTAINERS

DEVELOPMENTAL TESTING OF 60MM FOR PA190 & PA191 METAL CONTAINERS

Packaging Division Test Lab
Bldg. 403
March 2008

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FIGURES

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BACKGROUND

Recently, the US Army ARDEC initiated a program to determine the feasibility of eliminating the wire-bound box from the M2A1, PA124, and PA70 packaging configurations. This change is expected to reduce the overall lifecycle costs of the ammunition items packed in these containers.

All three containers have the same length and width and vary only in height. The M2A1 metal container cover was redesigned and tested by the Small Caliber Ammunition Team. Testing was limited to the taller PA124 for the Mortar Team as the worst case for determining the extent of structural damage and container side wall buckling as a result of the testing.

Transportation rough handling tests were conducted at temperature (hot and cold) and in the Packaging Division Test Facility (B403). The containers were transported to Bldg 3109 for pressure retention.

The M2A1 cover was not able to hold a seal as the mortar pack was heavier than the Small Cal pack (60 pounds vs 35 pounds). The mortar team had to adopt a PA154 double latch cover to maintain seal against the higher pack weight.

TEST PROCEDURE

Four sets of 12 PA124 container prototypes each were procured and tested. Each set had the enhanced body assembly (i.e., with diagonal ribs on sides) and different cover designs.

First Set: **Enhanced Body Sub-assembly Test - Without positive stop**
Second Set: **Enhanced M2A1 cover Test - With M2A1 positive stop**
Third Set: **M154 double latch cover**
Fourth Set: **M154 double latch cover with bottom plywood cushion**

For each set, six containers were tested in cold temperature condition (-65 degrees F) and six in hot temperature condition (+160 degrees F). The test sequence used followed MIL-STD-1904 for each set as follows:

1st Pressure Retention - Baseline
Loose Cargo Vibration
2nd Pressure Retention
3 Foot Drop (Six drops per container, 1 at each orientation)
3rd Pressure Retention
7 Foot Drop (one drop per container, at different orientations)

The packs were conditioned and then tested as quickly as possible after removal from the conditioning chamber to maintain the specified temperature level as close as possible to the required value.

OBSERVATIONS

All containers passed initial pressure retention, loose cargo vibration and second pressure retention test. The problems occurred after the three foot drop test during the third pressure retention test. There was leakage at either the top along the gasket seal or at the bottom seam weld of the metal container.

A. First set of 12 containers (PA124 container without positive stop):
After 3 foot drop test in cold condition, one container leaked from cover and another leaked from a bottom corner. For hot condition, only one container leaked from cover. See figures A-1, A-2, and A-3.

Figure A-1
Cold condition

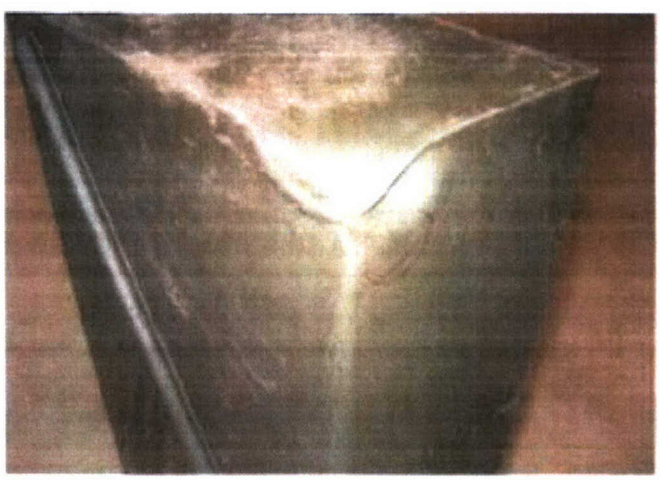

Figure A-2
Cold condition

Figure A-3
Hot condition

B. Second set of 12 containers (PA124 with positive stop):
Three containers failed pressure retention test after hot conditioned 3 foot drop test. See figures A-4, A-5, and A-6.

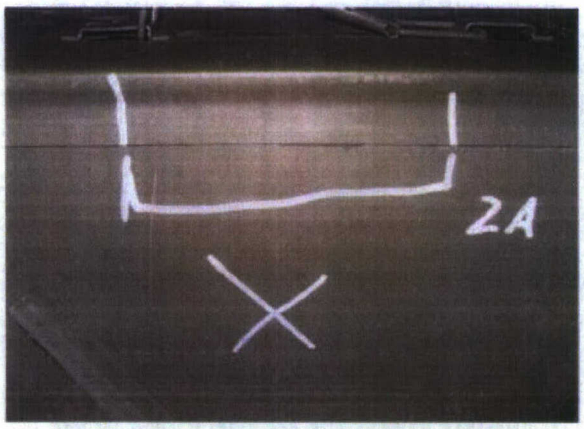

Figure A-4

Figure A-5

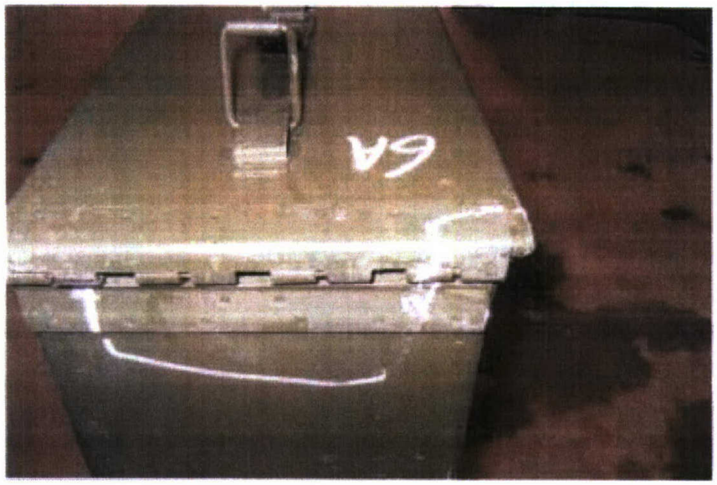

Figure A-6

C. Third set of 12 containers (PA124 with PA154 double latch cover):
Since most of the leakage occurred at the container cover, this indicated that a stronger cover is needed. As a result, it was decided to put a PA154 cover on PA 124 body. (Note that difference between PA154 and PA124 metal container is height.) The pressure retention test was conducted after the 3 foot drop test and resulted in no leaks from the container cover, but there were minor leaks from container bottom. One minor leak came from a cold conditioned sample and two minor leaks were from hot conditioned containers. See figures A-7, A-8, and A-9.

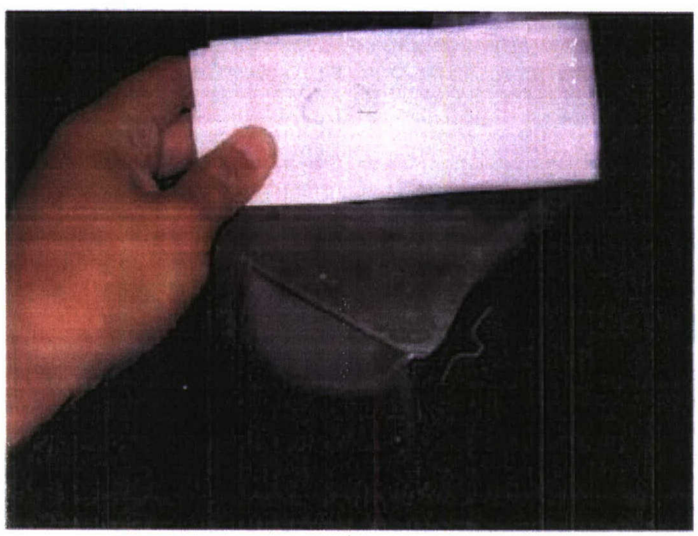

Figure A-7

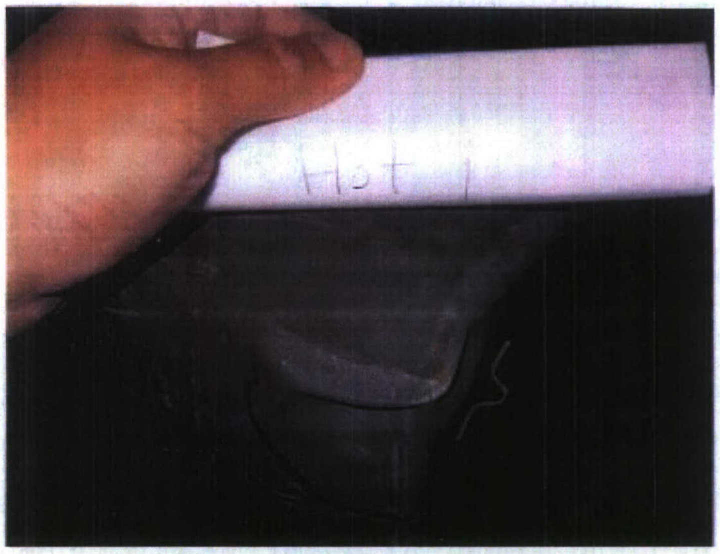

Figure A-8

Figure A-9

D. Fourth set of 12 containers (M154 cover and plywood):
The data obtained from the third test clearly showed the bottom was weak. As a result, it was decided to try a 0.25 in. thick piece of plywood packed at the bottom of each PA124 container body. After testing with the plywood "cushion," there was no container leaks observed from pressure retention testing after 3 foot drop tests were completed.

E. Instrumented Testing -

Refer to the following report for details regarding instrumented tests:

INSTRUMENTAL DROP TEST FOR 60MM PACKAGING SYSTEMS, FINAL REPORT, dated November 2007, Conducted by Frontier Performance Polymers.

Figure A-10 below shows the comparison of the peak loads from the first and second drops of four 60mm packaging configurations. It clearly shows that the effect of cushion (paper vs. foam) on the current wire-bound dual metal container packaging system is very small. However, the effect of cushion (paper vs. wood) on reinforced steel container is very significant. The peak load can be reduced as much as 50% by switching from paper board cushion to wood board cushion for the reinforced steel container packaging system. Overall, the reinforced steel container with wood board cushion results in much lower peak force than three other configurations from the seven foot vertical drop.

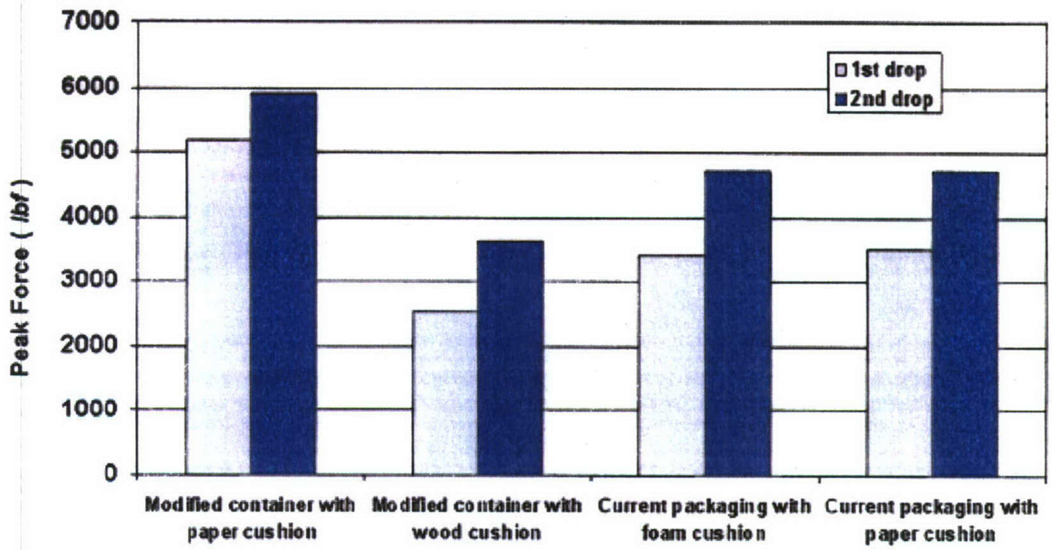

Figure A-10
Peak force comparison for four packaging configurations

Analysis of shock data: Based on the instrumented drop test results, it is clear that using wood board cushion in 60mm packaging systems can significantly reduce the peak force from seven foot vertical drop, and thus provide better protection for the rounds. In the current packaging system, the wire-bound wood box acts as a buffer zone between steel floor and containers, thus provides additional protection. In the reinforced steel container with a wood board cushion packaging configuration, the wood board is very effective to absorb impact energy and can better protect mortars from impact damage than current wire-bound packaging configurations. The paper board or foam cushion may be too thin and/or too weak to reduce the peak loads during impact and thus can not provide sufficient protection for the mortar rounds inside.

CONCLUSIONS

As the test results were collected and evaluated, it became clear that the enhanced M2A1 cover could not be strengthen enough to accommodate the 60 mm mortar pack weight. Use of the PA154 cover provided the strength needed. The new resulting container design will decrease the footprint of the packaged ammunition, increase transporter efficiency via higher item density and decrease the packaging over all life cycle cost. Elimination of layers of packaging ensures ammunition is delivered to our troops using the lightest, space efficient, and cost effective method.

APPENDIX B
INSTRUMENTAL DROP TEST FOR 60mm PACKAGING SYSTEMS

FPP
Frontier Performance Polymers

Final Report

Instrumental Drop Test

For 60mm Packaging Systems

By

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Date: November 5, 2007

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OBJECTIVE

The objective of this instrumental drop test is to determine the peak *g*-force and maximal impact load of various 60mm mortar packaging systems during vertical drops from seven foot height. The packaging systems tested were:

- Current packaging systems (wire-bound dual metal containers) with either foam or paper cushion.
- Reinforced single metal container with either wood or paper board cushion.

TEST PROCEDURES

The acceleration was measured using a PCB accelerometer (model 353b77) attached on the main body of the 60mm cartridge as shown in Figure 1. Two accelerometers were placed on two of eight cartridges packed in a metal container (Middle Round and Corner Round) as shown in Figure 2.

Figure 1. Placement of the accelerometer

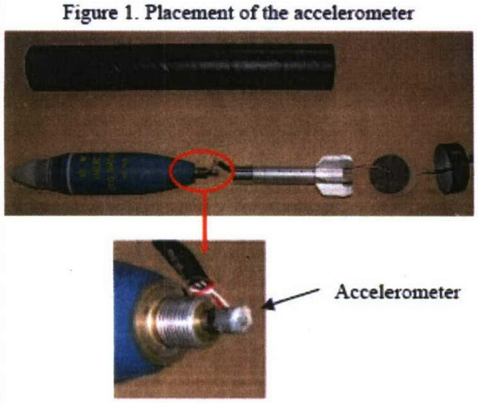
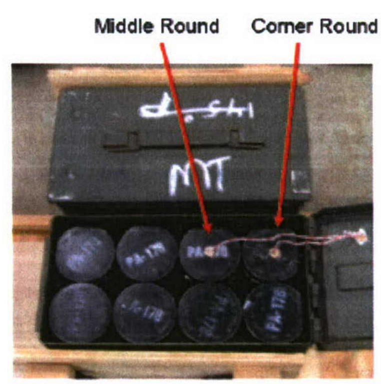


Figure 2. Drop test system setup.



Signals generated from accelerometers were conditioned by a PCB ICP® sensor signal conditioner (model 482A16) before being fed back to a data acquisition system. A high speed data acquisition DAQ board (Omega OMB-DAQ-3005) and the DAQView 9.0 software were used to acquire the data signals from the accelerometers. Sample rate was set to 500 KHz.

The signals from the accelerometers were collected by the PC data acquisition system as voltage-time curves. The voltage-time curves were then converted to acceleration-time curves. The final load-time curves were subsequently calculated from the acceleration-time curve using the cartridge weight of 4.16 pounds.

The instrumental impact tests were conducted on four 60mm package configurations shown as follow and the weight of each system is listed in Table 1.

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- Current wire-bound dual steel containers with a paper board cushion
- Current wire-bound dual steel containers with a foam cushion
- Modified reinforced single steel containers with a paper board cushion
- Modified reinforced single steel containers with a wood board cushion

Table 1. Weights of four tested 60mm packaging system configurations

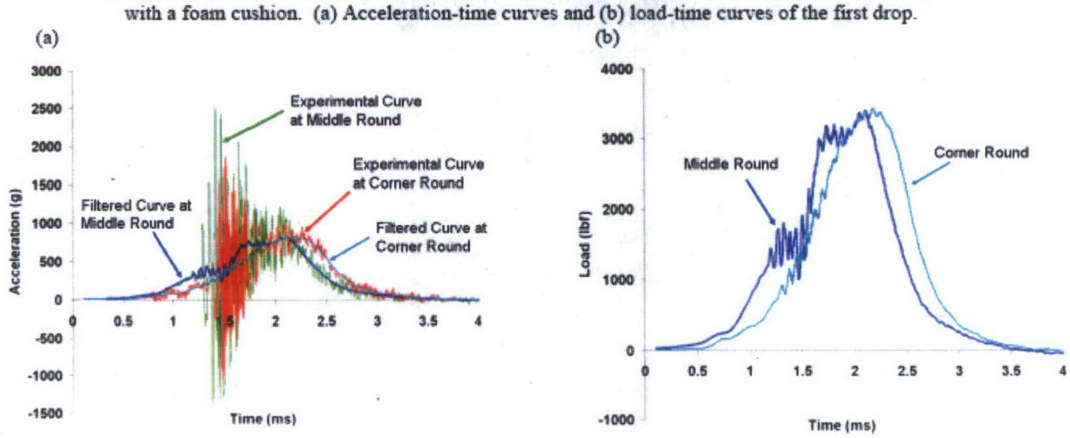
System	Cushion Material	System Weight (pounds)
Current Wire-Bound Container	Paper	114.4
Current Wire-Bound Container	Wood	114.7
Reinforced Steel Container	Foam	51.7
Reinforced Steel Container	Wood	51.9

All systems were vertically dropped (fin upward) from seven feet height as per MIL-STD-1904A and two consecutive drops were conducted for each packaging configuration.

RESULTS

Typical acceleration-time and load-time curves of the first seven-foot drop of the current wire-bound 60mm packaging configuration with a foam cushion are shown in Figures 3(a) and 3(b), respectively. Due to the intensity of impact, high frequency structure responses were observed as shown in Figure 3(a). Because the frequencies of these high frequency components exceed the accelerometer's measurement range, these frequencies are accurate but their amplitudes are not. Nevertheless, these high frequency components are irrelevant in determining peak forces and were filtered out through a moving averaging numeric technique.

Figure 3. Instrumental drop test results for the current 60mm wire-bound package configuration with a foam cushion. (a) Acceleration-time curves and (b) load-time curves of the first drop.



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The filtered acceleration-time curve represents rigid body movement of the cartridge during the impact cycle. Small delay between responses of middle round and corner round seen in Figure 3 is due to the misalignment of the rounds in the container at the moment of impact. The peak accelerations and peak loads can be easily obtained from acceleration-time and load-time curves. The peak accelerations and impact duration times from seven foot vertical drop of four different packaging configurations are summarized in Table 1.

Table 2 Peak accelerations and the durations of impact of the middle and corner rounds from seven foot drop of four 60mm packaging configurations

Package Type	Cushion Type	Drop Order	Peak Acceleration (Middle Round) (g)	Duration (Middle Round) (millisecond)	Peak Acceleration (Corner Round) (g)	Duration (Corner Round) (millisecond)
Modified Container	Paper	1st	1,280	2.6	1,200	2.3
		2nd	1,470	1.8	1,370	1.9
	Wood	1st	580	3.5	6,50	3.3
		2nd	7,50	2.7	1,000	2.5
Current Packaging	Foam	1st	820	3.0	820	3.0
		2nd	1,210	2.3	1,060	2.3
	Paper	1st	830	2.8	860	2.7
		2nd	1,080	2.5	1,190	2.3

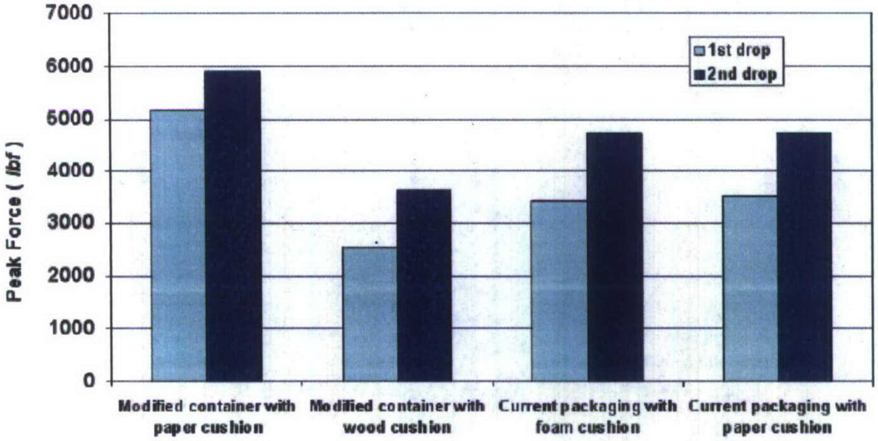
The load-time curve was then calculated from the acceleration-time curve with the cartridge weight (not system weight). The maximum load of the middle round, peak load of the corner round and average peak load of middle round and corner round in eight drops (two consecutive seven foot drops of four tested packaging configurations) are shown in Table 3.

Table 3. Peak loads of middle and corner rounds and average peak loads from seven foot drop of four 60mm packaging configurations

Package Type	Cushion Type	Drop Order	Peak Load (Middle Round) (Pounds force)	Peak Load (Corner Round) (Pounds force)	Peak Load (Average) (Pounds force)
Modified Container	Paper	1st	5,340	5,010	5,175
		2nd	6,110	5,680	5,895
	Wood	1st	2,410	2,700	2,555
		2nd	3,130	4,150	3,640
Current Packaging	Foam	1st	3,400	3,430	3,415
		2nd	5,050	4,400	4,725
	Paper	1st	3,460	3,590	3,525
		2nd	4,500	4,940	4,720

Figure 4 shows the comparison of the peak loads from the first and second drops of four 60mm packaging configurations. It clearly shows that the effect of cushion (paper vs. foam) on the current wire-bound dual metal container packaging system is very small. However, the effect of cushion (paper vs. wood) on reinforced steel container is very significant. The peak load can be reduced as much as 50% by switching from paper board cushion to wood board cushion for the reinforced steel container packaging system. Overall, the reinforced steel container with wood board cushion results in much lower peak force than three other configurations from the seven foot vertical drop.

Figure 4. Peak Force Comparison for four packaging configurations



CONCLUSIONS

Based on the instrumental drop test results, it is clear that using wood board cushion in 60mm packaging systems can significantly reduce the peak force from seven foot vertical drop, and thus provide better protection for the rounds. In the current packaging system, the wire-bound wood box acts as a buffer zone between steel floor and containers, thus provides additional protection. In the reinforced steel container with a wood board cushion packaging configuration, the wood board is very effective to absorb impact energy and can better protect mortars from impact damage than current wire-bound packaging configurations. For the paper board or foam cushion, it may be too thin and/or too weak to reduce the peak loads during impact, thus could not provide sufficient protection for the mortar rounds inside.

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APPENDIX C
PRELIMINARY TEST SOR NEWLY DESIGNED PA124 AND PA70

PRELIMINARY TEST FOR NEWLY DESIGNED PA124 & PA70

ENVIRONMENTAL TEST GROUP
Bldg. 3109
March, 2008

WRITTEN BY: ___________________________
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SUMMARY

The following report documents evaluation of modified PA124 and PA70 containers. Testing of the Hardware included Loose Cargo Vibration Test, 3 and 7 Foot Drop Test, and Pressure Retention Test. All hardware went through a series of environmental testing using MIL-STD-1904 for guidance. The test results for the item are described below.

BACKGROUND

This effort focuses on the development of minor design changes to two metal container cans to eliminate the need for the wire bound box over pack.

Packaging division conducted prototype testing for improved PA 124 back in April 2007 with four different sets of containers. Four sets were following:

- PA124 container without positive stop
- PA124 container with positive stop
- PA124 with M548 double latch cover
- PA124 with M548 cover and plywood

Based on testing results of the above prototype test for improved PA 124, packaging division determined the final designs of improved PA 124 & PA70.

Therefore, this preliminary test is to determine the performance of improved PA124 & PA 70 final designed metal containers.

This new designed can will decrease the footprint of the packaged ammunition, increased transporter efficiency via higher item density and decrease the packaging over all cost. Elimination of layers of packaging ensures the ammunition is delivered to our troops using the lightest, space efficient, and cost effective method.

The Loose Cargo Vibration Testing, 3 Foot and 7 Foot Drop Testing are required to simulate the transportation of items carried as unsecured cargo in trucks and tracked vehicles, and loading and unloading of these vehicles. This test will provide a degree of confidence that the Hardware can physically withstand vibration, drop and environmental conditions encountered in service environment.

The Environmental Test Group at ARDEC was assigned to conduct this testing.

OBJECTIVE

To subject PA124 and PA70 to various Environmental Tests in order to determine the effects on the integrity of the design, manufacturing, life cycle conditions, as well as the effects on the safety.

TEST ITEMS & EQUIPMENT

ITEMS and EQUIPMENT:

Six cans (PA124 & PA70 each) were conditioned to -65F, six cans were conditioned to +160F. Each can contained eight 60-mm cartridges. The technical evaluation consists of determining the functional envelope, durability, reliability, and overall performance. Pressure retention was performed before and after the test.

TEST PREPARATIONS:

1. All components were unpackaged, visually inspected and identified before commencement of testing. No obvious defects that could potentially affect performance were detected. All items were than repacked into appropriate packaging in preparation for testing.
2. Tests were conducted in sequence and in accordance with the following:
   a. MIL-STD-1904

TEST DESCRIPTIONS

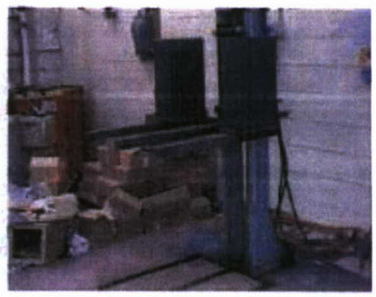
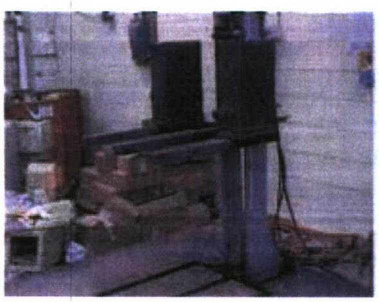
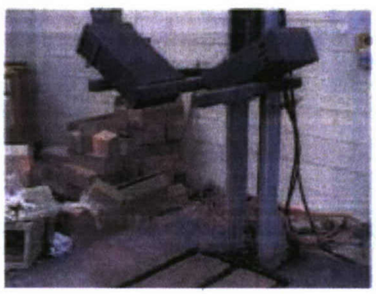
A. 3 & 7 Foot Drop Test (Required in POP Testing and Rough Handling Testing)

Start Date: Feb. 2008
Equipment: LAB Package Drop Tester.

Transit Drop was performed on packaged Cartridges.
The height specified is the distance from rigid surface (drop plate) to the nearest corner, edge or flat surface of the metal container.

3 Foot Drop: Each container was dropped one time in six different orientations; 6 Containers were tested at -65 F, 6 Containers were tested at +160 F. (PA124 & PA70 each)

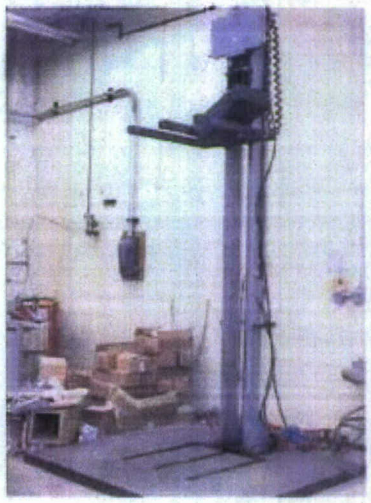
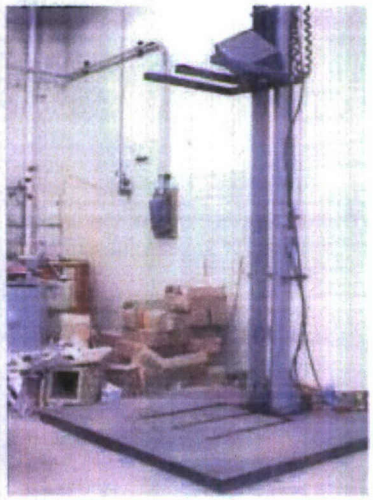



7 Foot Drop: Each container was dropped one time. Each container was dropped in different orientation. 6 Containers were tested at -65 F, 6 Containers were tested at +160 F. (PA124 & PA70 each)





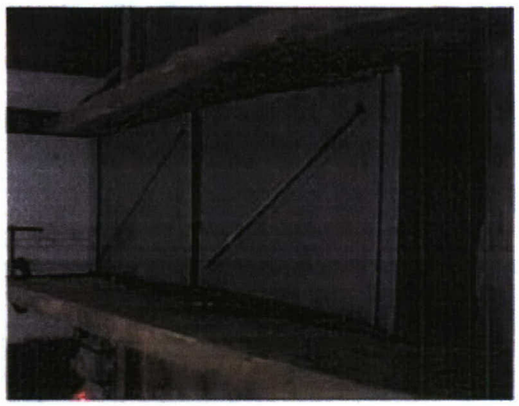



Transit drop is intended for equipment in its transit or combination case as prepared for field use (carried to a combat situation by man, trailer, truck, etc.).

B. **Loose Cargo Vibration**: (Required in POP Testing and Rough Handling Testing)

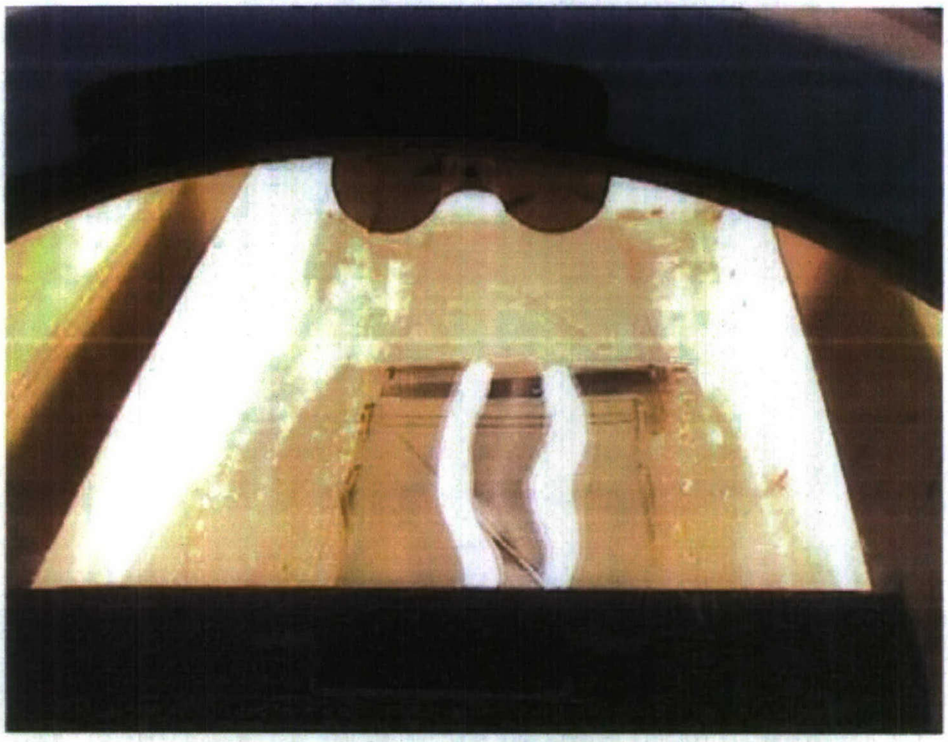
Start Date: Feb. 2008
Equipment: 1,000 lb. LAB Loose Cargo Package Tester.

A loose cargo test was performed with items in their packaged configuration. This test is intended to simulate the unrestrained collision of the test item with the bed and sides of the transport vehicle as well as with other cargo. Items were placed on steel surface of the vibration test equipment. The items were unrestrained during vibration except by a wood fence to prevent it from falling off the equipment.
The vibratory frequency was 5Hz (300 ROM) and vibratory surface had rotational one inch double amplitude (1 inch peak to peak). Test duration of 30 minutes represented 100 miles of truck transportation over the various road profiles. All containers were tested for 15 minutes on horizontal and vertical faces. Total test duration was 30 minutes. Six Containers were tested at +160 F. Six Containers were tested at -65 F. (PA124 & PA70 each)



<u>CONCLUSION</u>

1. Pass or fail criteria will be established by AMSRD-AAR-AIL-P at Picatinny at the conclusions of physical inspection.
2. All containers, PA124 and PA70, were leak tested at the conclusions of physical testing.
3. All containers passed Leak Test.



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